Docket No. 03-0418

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

APPEAL NO. ___________________

First named inventor:
Maurice Peter Bianchi

Confirmation No. 2668

Serial No. 10/806,710

Filed: June 23, 2004

Examiner: Jayne L. Mershon

Art Unit: 1795

Title: SOLAR CELL ASSEMBLY

APPEAL BRIEF

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1. REAL PARTY IN INTEREST

The real party in interest is the assignee, The Boeing Company.

2. RELATED APPEALS AND INTERFERENCES

No appeals or interferences are known to have a bearing on the Board's decision in the pending appeal.

3. STATUS OF CLAIMS

Claims 3, 6, 17-19 and 23-24 are cancelled.

Claims 1, 2, 4-5, 7-16, 20-22 and 25-26 are pending.

Claims 1, 2, 4-5, 7-16, 20-22, and 25-26 are rejected.

The rejections of claims 1, 2, 4-5, 7-16, 20-22, and 25-26 are being appealed.

4. STATUS OF AMENDMENTS

No amendment was filed subsequent to the final rejection dated July 6, 2010.

5. SUMMARY OF CLAIMED SUBJECT MATTER

The original application filed 3 March 2004 does not contain liner numbers. Reference will be made to paragraph numbers in the pre-grant publication, United States Patent Application No. 20050211291.

The claims are drawn to a solar cell assembly including an indium gallium nitride (InGaN) solar cell and a transparent conductive coating (TCC) made of gallium nitride (GaN). Paragraphs 19-20 of the specification teach that a GaN TCC provides a defect-free surface for growing an InGaN solar cell. This unexpected result provides real benefits. It allows the InGaN solar cell to be grown on the TCC (which is grown on a sapphire cover), thus forming a unitary assembly. No adhesive is needed to attach the cover to the solar cell. No other corrective measures are made to the solar cell or TCC.

The claims recite that the InGaN solar cell is “grown on” the GaN TCC. The term “grown on” does not refer to a method step or an “intended use” (as the final office action alleges). Rather, it refers to a structural relationship between the solar cell and the TCC. When a solar cell is grown on a surface of the TCC, there is intimate contact between the TCC and the solar cell.

Base claim 1

Base claim 1 recites a multi-junction solar cell assembly. Figure 1 illustrates an example of such a solar cell assembly 20. The solar cell assembly 20 of Figure 1 includes a sapphire cover 22 (paragraph 15) and a transparent conductive coating 24 formed on the sapphire cover 22 (paragraph 16). The TCC 24 functions as a collector for conducting solar photon-generated current from the surface of a cell. The transparent conductive coating comprises gallium nitride to provide a defect-free surface for growing an InGaN solar cell (paragraph 20).

An example of such a TCC is illustrated in Figures 4A-4C. A lateral epitaxial overgrowth layer (generally designated by 48) is formed on the sapphire cover 22 "to reduce defects in the TCC caused by a lattice mismatch between the TCC and the substrate" (paragraph 19). The overgrowth layer is grown in a way that prevents dislocations from propagating into subsequent growth layers formed on the lateral epitaxial overgrowth layer (paragraph 20). Defect-free layers of GaN can be formed on the lateral epitaxial overgrowth layer 48 to generally form the TCC 24 on the sapphire cover 22 without defects, despite a lattice mismatch between the TCC and the cover 22 (paragraph 20).

The solar cell assembly 20 further includes a solar cell including a plurality of gallium indium nitride junction layers 26 grown successively on the transparent conductive coating (paragraphs 21-22); an indium nitride junction layer 34 formed on the plurality of gallium indium nitride junction layers (paragraph 14); and a metallization layer 28 formed on the indium nitride junction layer 34 (paragraph 14).

Each successive gallium indium nitride junction layer has a thickness greater than a thickness of the immediately preceding gallium indium nitride junction layer (paragraph 25). Each successive gallium indium nitride junction layer is directly adjacent the immediately preceding gallium indium nitride junction layer.

Base claim 20

Base claim 20 recites a method of forming a unitary multi junction solar cell assembly. The method comprises forming a transparent conductive coating 24 including gallium nitride on a sapphire cover 22 (Figures 4A-4C and paragraphs 19-20). The method further comprises growing a solar cell including a plurality of gallium indium nitride junction layers 26 on the TCC 24 without taking any measures to correct for lattice mismatch (Figure 1 and paragraphs 21-22).

Base claim 25

Base claim 25 recites a solar cell assembly comprising a sapphire cover 22 (Figure 1 and paragraph 15) and a GaN transparent conductive coating 24 as front collector. The GaN TCC 24 is formed on the sapphire cover 22 (Figure 1 and paragraph 16; and Figures 4A-4C and paragraphs 19-20).

The solar assembly further comprises a multjunction InGaN solar cell grown on a GaN layer of the TCC (Figure 1 and paragraphs 21-22 describe a mutlijunction solar cell having multiple layers of InGaN junction layers 26). As explained in paragraphs 19-20 of the specification, the GaN TCC provides a defect-free surface upon which the InGaN solar cell is grown.

Dependent claim 26

Claim 26 recites the solar cell assembly of claim 25, wherein the TCC is formed as a plurality of quantum wells 36 (paragraph 16), and wherein the InGaN solar cell is in intimate contact with the GaN layer (paragraph 21).

6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

a. Rejection of claims 25, 5, 7-14, 16 and 26 under 35 USC §103(a) as being unpatentable over Bianchi U.S. Patent No. 6,447,938 in view of Iles U.S. Patent No. 6,951,819, and a paper by Wu et al. entitled "Superior radiation resistance in InGaN alloys."

b. Rejection of claims 1-2, 4 and 15 under 35 USC §103(a) as being unpatentable over Bianchi U.S. Patent No. 6,447,938 in view of Iles U.S. Patent No. 6,951,819, a paper by Wu et al. entitled "Superior radiation resistance in InGaN alloys" and Sverdrup U.S. Publication No. 20030041894.

c. Rejection of claims 20-22 under 35 USC §103(a) as being unpatentable over Iles U.S. Patent No. 6,951,819 in view of a paper by Wu et al. entitled "Superior radiation resistance in InGaN alloys" and Bianchi U.S. Patent No. 6,447,938.

d. Rejection of claims 20-22 under 35 USC §112, first paragraph, as not complying with the written description requirement.

7. ARGUMENTS

The pending claims are rejected under section 103 as being unpatentable over Bianchi, Iles, and a paper by Wu (collectively, the cited documents). The cited documents will now be discussed. Then, each rejection will be addressed. It will be argued that the cited documents, alone and in combination, do not teach or suggest an InGaN solar cell grown on a GaN TCC.

Bianchi describes a solar cell including a sapphire substrate, GaN TCC, and a GaAs solar cell on the TCC. The GaN TCC does not provide a defect free surface for growing a GaAs solar cell. In order to minimize lattice mismatch between the GaAs solar cell and the GaN TCC, a corrective measure is taken. The corrective measure includes a layer of indium gallium phosphide (InGaP) between the TCC and solar cell (col. 6, lines 55-59); a super lattice formed at the interface of the solar cell and TCC (col. 7, lines 7-11); a graded layer (col. 7, lines 22-24); or an offset method (col. 7, lines 22-29).

Bianchi is silent about InGaN solar cells. In any event, Bianchi is silent about growing an InGaN solar cell on a TCC or other substrate.

Wu describes InGaN solar cells, but is silent about covers and TCCs for InGaN solar cells. Wu is also silent about lattice mismatches with substrates upon which an InGaN solar cell is grown.

If anything, Wu provides clear evidence that the state of the art has not progressed to issues involved with growing an InGaN device on a cover. Wu states that “Work on InGaN has not yet progressed to the point of making complete devices, so we have chosen to study here basic material properties” (p. 6478, left column).

Iles is silent about growing solar cells of any type on a cover or TCC. Iles describes a solar cell that is grown on a parting layer 16, so it can be released

from a supporting substrate 14 (col. 7, lines 18-21). After parting, the solar cell is free standing. A support substrate 28 having layers of metallization 32, 32 is then bonded to the solar cell 40 (col. 7, lines 51-54 and col. 8, lines 15-16). A cover is also bonded to the solar cell (col. 14, lines 60-61).

The solar cell of Iles has layers that are lattice-mismatched (Abstract, lines 1-2). The layers are made of similar material. Iles describes a grading process to overcome the lattice mismatch between layers of similar material (see, e.g., col. 7, lines 6-17).

Iles provides several concrete examples of solar cells, none of which are made of InGaN. *A*n InGaN solar cell is mentioned only in passing. Iles does not offer guidance about growing an InGaN solar cell on a substrate. Iles does not teach or suggest that a GaN TCC provides a defect-free surface for growing an InGaN solar cell.

I

REJECTION OF CLAIMS 25, 5, 7-14, 16 AND 26 UNDER 35 USC §103(A) AS BEING UNPATENTABLE OVER BIANCHI U.S. PATENT NO. 6,447,938 IN VIEW OF ILES U.S. PATENT NO. 6,951,819, AND A PAPER BY WU ET AL. ENTITLED "SUPERIOR RADIATION RESISTANCE IN INGAN ALLOYS"

Claims 25, 5, 7-14 and 16

The '103 rejection is based on factual and legal deficiencies.

None of the cited documents describes a multjunction InGaN solar cell grown on a GaN TCC. None of the cited documents recognizes that a GaN TCC provides a defect-free surface upon which the InGaN solar cell is grown.

Bianchi is silent about InGaN solar cells. Wu provides clear evidence that the state of the art has not progressed to issues involved with growing an InGaN

device on a TCC. Iles describes adhesively bonding a free standing solar cell to a glass cover.

The final office action alleges that the GaN TCC provides a defect-free surface (see, e.g., pages 8 and 14). However, the allegation is not supported by the evidence made of record. In fact, the only document that describes a TCC - Bianchi - expressly contradicts the allegation. Bianchi describes a corrective measure in order to form a GaAs solar cell and TCC as a unitary assembly.

Therefore, the combined teachings of Bianchi, Iles and Wu do not produce a solar cell assembly having all of the features recited in claim 25. Due to this factual deficiency, the '103 rejection of claim 25 should be withdrawn.

The final office action commits legal error because it does not comply with MPEP 2142 and the U.S. Supreme Court's holding in KSR International Co. v. Teleflex Inc., 82 USPQ2d 1385, 1395-97 (2007). In KSR, the Supreme Court held "rejections on obviousness cannot be sustained with mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness."

Page 6 of the final office action alleges that it would be obvious to substitute the GaAs solar cell of Bianchi with the InGaN solar cell of Iles. In order to establish prima facie obviousness under this rationale, the final office action must provide "a finding that one of ordinary skill in the art could have substituted one known element for another, and the results of the substitution would have been predictable."

The cited documents are all silent about a GaN TCC providing a defect free surface for an InGaN solar cell. If anything, Wu provides evidence that there was no expectation of the GaN TCC providing a defect-free surface. Wu states that "Work on InGaN has not yet progressed to the point of making complete

devices…." Therefore, the final office action provides neither rational underpinnings nor a clear articulation to support the '103 rejection of claim 25.

Due to these factual and legal deficiencies, the '103 rejection should be withdrawn.

Claim 26

None of these documents describes an InGaN solar cell in intimate contact with the GaN layer. Bianchi describes a layer of indium gallium phosphide between the TCC and GaAs solar cell (col. 6, lines 55-59). Iles describes a layer of adhesive between a multi-junction solar cell and a support substrate 28 having metallization layers 32. Wu is silent about a TCC.

Thus, the combined teachings of Bianchi, Iles and Wu do not produce a solar cell assembly having all of the features of claim 26. Due to this additional factual deficiency, the '103 rejection of claim 26 should be withdrawn.

II

REJECTION OF CLAIMS 1-2, 4 AND 15 UNDER 35 USC §103(A) AS BEING UNPATENTABLE OVER BIANCHI U.S. PATENT NO. 6,447,938 IN VIEW OF ILES U.S. PATENT NO. 6,951,819, A PAPER BY WU ET AL. ENTITLED "SUPERIOR RADIATION RESISTANCE IN INGAN ALLOYS" AND SVERDRUP U.S. PUBLICATION NO. 20030041894

Base claim 1 is rejected for the same reasons as base claim 25 (see page 9 of the final office action). Sverdrup is cited only for teaching about the thickness of layers in a solar cell. Thus, the '103 rejection of base claim 1 incorporates the same legal and factual deficiencies as the '103 rejection of base claim 25.

Argument I is incorporated herein by reference. The combined teachings of Bianchi, Iles and Wu do not produce a solar cell assembly including a GaN TCC that provides a defect-free surface for an InGaN solar cell. The final office action provides no finding of predictable result that a GaN TCC provides a defect free surface for an InGaN solar cell. If anything, Wu provides evidence that the result was not predictable. The final office action offers little more than a conclusory statement of obviousness.

III

REJECTION OF CLAIMS 20-22 UNDER 35 USC §103(A) AS BEING UNPATENTABLE OVER ILES U.S. PATENT NO. 6,951,819 IN VIEW OF A PAPER BY WU ET AL. ENTITLED "SUPERIOR RADIATION RESISTANCE IN INGAN ALLOYS" AND BIANCHI U.S. PATENT NO. 6,447,938.

The '103 rejection is based on factual and legal deficiencies. The '103 rejection is based on factual deficiencies because it provides no evidence that would lead one skilled in the art to grow an InGaN solar cell on a GaN transparent conductive coating without taking any measures to correct for lattice mismatch. Wu is silent about growing InGaN solar cells on a substrate. So is Iles, which merely describes corrective measures for growing multiple layers of a free-standing solar cell. Bianchi only describes a GaAs solar cell and a GaN TCC. Moreover, Bianchi takes corrective measures to grow the GaAs solar cell. Thus, the combined teachings of do not produce a method having all of the features of claim 20. For this reason alone, the '103 rejection should be withdrawn.

The '103 rejection is based on legal deficiencies because it does not consider the obviousness of the claimed method as a whole. Rather it considers the obviousness of the differences. The final office action notes that Iles does not describe growing a solar cell on a TCC, so it cites Bianchi. The final office action then notes that neither document specifically describes an InGaN solar cell, so it cites Wu.

According to MPEP 2141.02, "In determining the differences between the prior art and the claims, the question under 35 U.S.C. 103 is not whether the differences <u>themselves</u> would have been obvious, but whether the claimed invention <u>as a whole</u> would have been obvious." <u>Stratoflex, Inc. v. Aeroquip Corp.</u>, 713 F.2d 1530, 218 USPQ 871 (Fed. Cir. 1983); <u>Schenck v. Nortron Corp</u>., 713 F.2d 782, 218 USPQ 698 (Fed. Cir. 1983).

The final office action does not provide a clear teaching that a GaN TCC provides a defect free surface for an InGaN solar cell. The final office action provides no evidence that it would be obvious to grow an InGaN solar cell on a GaN transparent conductive coating without taking any measures to correct for lattice mismatch. It also ignores the fact that Bianchi takes corrective measures. The final office action only considers whether the differences are obvious. For this additional reason, the ‘103 rejection should be withdrawn.

The ‘103 rejection is based on still further legal error because it does not comply with MPEP 2142 and <u>KSR International Co. v. Teleflex Inc.,</u> 82 USPQ2d 1385, 1395-97 (2007). In KSR, the Supreme Court held that “rejections on obviousness cannot be sustained with mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness."

The final office action provides the following rational underpinnings: Iles describes growing a solar cell on a parting layer. The solar cell is then removed from the parting layer. This free standing solar cell is then bonded to metallic electrical contact grids and a glass cover. Iles provides several examples, none of which involve InGaN solar cells. Bianchi describes a GaAs solar cell assembly including a GaAs solar cell, TCC, and an InGaP layer therebetween to correct for a lattice mismatch. Bianchi is silent about InGaN solar cells, and Iles only mentions one in passing. Wu describes InGaN solar cells, but is silent about lattice mismatches with substrates upon which their solar cell is grown.

The final office action provides no explanation of how these teachings would lead a person skilled in the art to grow an InGaN solar cell on a GaN transparent conductive coating <u>without taking any measures to correct for lattice mismatch</u>. The final office action merely alleges that the TCC of Bianchi does not propagate defects due to a lattice mismatch.

Moreover, Bianchi contradicts the allegation. Bianchi expressly describes corrective measures (grading, super lattice, InGaP layer) between a TCC and GaAs solar cell.

Thus, the final office action provides neither rational underpinnings nor a clear articulation to support the ‘103 rejection of claim 20. For this additional reason, the ‘103 rejection should be withdrawn.

IV
REJECTION OF CLAIMS 20-22 UNDER 35 USC §112, FIRST PARAGRAPH, AS NOT COMPLYING WITH THE WRITTEN DESCRIPTION REQUIREMENT

The final office action alleges that the specification does not provide support for the feature "growing a solar cell including a plurality of gallium indium nitride junction layers on the transparent conductive coating without taking any measures to correct for lattice mismatch." We respectfully disagree.

To satisfy the written description requirement, a patent specification must describe the claimed invention in sufficient detail that one skilled in the art can reasonably conclude that the inventor had possession of the claimed invention. See, e.g., Moba, B.V. v. Diamond Automation, Inc., 325 F.3d 1306, 1319, 66 USPQ2d 1429, 1438 (Fed. Cir. 2003).

Paragraphs 19-20 of the specification describe a TCC that provides a defect free surface upon which a solar cell can be grown. Paragraphs 21-23 and 33 describe a solar cell that can be grown on the TCC, thus forming a unitary assembly. Paragraph 21 describes the solar cell in intimate contact with the TCC. Thus, the solar cell is grown on the TCC without taking any corrective measures (paragraph 33). Therefore, the specification satisfies the written description requirement.

Moreover, the '112 rejection is based on legal error, as it appears to require the exact language of claim 20 to appear in the specification. However, that is not the test for the written description requirement. According to MPEP 2163, to satisfy the written description requirement, a patent specification must describe the claimed invention in sufficient detail that one skilled in the art can reasonably conclude that the inventor had possession of

the claimed invention. The specification does not contain the exact phrase "growing a solar cell including a plurality of gallium indium nitride junction layers on a transparent conductive coating without taking any measures to correct for lattice mismatch." However, paragraphs 19-23 and 33 describe that phrase.

For these reasons, the '112 rejection of claims 20-22 should be withdrawn.

For the reasons above, the rejections should be reversed. The Honorable Board of Patent Appeals and Interferences is respectfully requested to reverse these rejections.

Respectfully submitted,

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Date: January 10, 2010

8. CLAIMS APPENDIX

1. (Previously presented) A multi-junction solar cell assembly comprising:

a transparent substrate;

a transparent conductive coating formed on the transparent substrate, said transparent conductive coating comprising gallium nitride to provide a defect-free surface for growing an InGaN solar cell;

a solar cell including a plurality of gallium indium nitride junction layers grown successively on the transparent conductive coating;

an indium nitride junction layer formed on the plurality of gallium indium nitride junction layers; and

a metallization layer formed on the indium nitride junction layer;

wherein each successive gallium indium nitride junction laver has a thickness greater than a thickness of the immediately preceding gallium indium nitride junction layer, each successive gallium indium nitride junction layer being directly adjacent the immediately preceding gallium indium nitride junction layer.

2. (Original) A multi junction solar cell assembly in accordance with claim 1 wherein the transparent substrate is selected from a group of transparent substrates consisting of sapphire, zinc oxide, and gallium nitride.

3. (Canceled).

4. (Previously presented) A multi junction solar cell assembly in accordance with claim 1 further comprising a gallium nitride

junction layer between the transparent conductive coating and the plurality of gallium Indium nitride junction layers.

5. (Previously presented) The solar cell assembly of claim 25, wherein the solar cell includes a plurality of gallium indium nitride junction layers having a thickness of between about 0.2 microns and about 1.0 microns.

6. (Canceled).

7. (Previously presented) The solar cell assembly of claim 5, wherein each layer of the plurality of gallium indium nitride junction layers has a gallium content of between about 90 wt % and about 10 wt % and an indium content of between about 90 wt % and about 10 wt %.

8. (Previously presented) The solar cell assembly of claim 5, wherein each successive layer of the plurality of gallium indium nitride junction layers has a gallium content less than the immediately preceding layer of the plurality of gallium indium nitride junction layers and an indium content greater than the immediately preceding layer of the plurality of gallium indium nitride junction layers.

9. (Previously presented) The solar cell assembly of claim 5, wherein each layer of the plurality of gallium indium nitride junction layers has a band gap of between about 0.7 eV and about 3.4 eV.

10. (Previously presented) The solar cell assembly of claim 5, wherein each successive layer of the plurality of gallium indium

nitride junction layers has a band gap less than the band gap of the immediately preceding layer of the plurality of gallium indium nitride junction layers.

11. (Previously presented) The solar cell assembly of claim 25, wherein the transparent conductive coating comprises:

a nucleation layer formed on the sapphire cover;
a lateral epitaxial overgrowth layer of gallium nitride formed on the nucleation layer; and
a defect-free gallium nitride layer formed on the lateral epitaxial overgrowth layer.

12. (Previously presented) The solar cell assembly of claim 11, wherein the nucleation layer comprises:

an aluminum nitride coating formed directly on the sapphire cover in intimate contact with the sapphire cover; and

a seed layer of gallium nitride formed on the aluminum nitride coating.

13. (Previously presented) The solar cell assembly of claim 25, wherein the transparent conductive coating comprises:

a plurality of alternating layers of gallium nitride and aluminum gallium nitride; and

a plurality of quantum wells, each quantum well of the plurality of quantum wells formed at a corresponding interface between adjacent layers of gallium nitride and aluminum gallium nitride of the plurality of alternating layers of gallium nitride and aluminum gallium nitride.

14. (Previously presented) The solar cell assembly of claim 13 wherein a first gallium indium nitride junction layer of the plurality of gallium indium nitride junction layers is formed directly on a last gallium nitride layer of the plurality of alternating layers of gallium nitride and aluminum gallium nitride in intimate contact with the last gallium nitride layer of the plurality of alternating layers of gallium nitride and aluminum gallium nitride.

15. (Original) A multi junction solar cell assembly in accordance with claim 1 wherein the transparent conductive coating comprises a gallium nitride layer formed on the transparent substrate.

16. (Previously presented) The solar cell assembly of claim 5, further comprising a metal current collector bus for receiving electrical power collected from the plurality of gallium indium nitride junction layers by the transparent conductive coating.

17-19 (Cancelled)

20. (Previously presented) A method of forming a unitary multi junction solar cell assembly comprising:

forming a transparent conductive coating including gallium nitride on a sapphire cover; and

growing a solar cell including a plurality of gallium indium nitride junction layers on the transparent conductive coating without taking any measures to correct for lattice mismatch.

21. (Previously presented) A method in accordance with claim 20 further comprising forming a metallization layer on the plurality

of gallium indium nitride junction layers, wherein the metallization layer is selected from a group that includes a layer of aluminum, a layer of chromium, and a layer of titanium; and forming an Indium nitride junction layer on the plurality of gallium indium nitride junction layers between the metallization layer and the plurality of gallium indium nitride junction layers.

22. (Previously presented) A method in accordance with claim 20 further comprising forming a gallium nitride junction layer on the transparent conductive coating between the transparent conductive coating and the plurality of gallium indium nitride junction layers.

23-24. (Cancelled)

25. (Previously presented) A solar cell assembly comprising:

a sapphire cover;

a GaN transparent conductive coating (TCC) as front collector, the GaN TCC formed on the sapphire cover; and

a multjunction InGaN solar cell grown on a GaN layer of the TCC;

wherein the GaN TCC provides a defect-free surface upon which the InGaN solar cell is grown.

26. (Previously presented) The solar cell assembly of claim 25, wherein the TCC is formed as a plurality of quantum wells; and wherein the InGaN solar cell is in intimate contact with the GaN layer.

9. EVIDENCE APPENDIX

None

10. RELATED PROCEEDINGS APPENDIX

None